AIR POLLUTION

HEALTH AND ENVIRONMENTAL IMPACTS

Air pollution can affect our health in many ways. Numerous scientific studies have linked air pollution to a variety of health problems including (1) aggravation of respiratory and cardiovascular disease (as indicated by increased emergency department visits and hospital admissions); (2) decreased lung function and increased frequency and severity of respiratory symptoms such as difficulty breathing and coughing; (3) increased susceptibility to respiratory infections; (4) effects on the nervous system, including the brain, such as IQ loss and impacts on learning, memory, and behavior; (5) cancer; and (6) premature death. Some sensitive individuals appear to be at greater risk for air pollution-related health effects, for example, those with pre-existing heart and lung diseases (e.g., asthma, emphysema, and chronic bronchitis), diabetics, older adults, and children. In 2007, 158.5 million people lived in counties that exceeded national air quality standards.

Air pollution also damages our environment. Ozone can damage vegetation including adversely impacting the growth of trees and reducing crop yields. Visibility is reduced by particle pollutants that scatter and absorb light. Typical visual range in the eastern U.S. is 15 to 30 miles, approximately one-third of what it would be without man-made air pollution. In the West, the typical visual range is about 60 to 90 miles, or about one-half of the visual range under natural conditions.

Pollution in the form of acids and acid-forming compounds (such as sulfur dioxide [SO_2] and oxides of nitrogen [NO_x]) can deposit from the atmosphere to the Earth's surface. This is called acid deposition and can be either dry or wet. Wet deposition is more commonly known as acid rain. Acid rain can occur anywhere and, in some areas, rain can be 100 times more acidic than natural precipitation. Acid deposition can be a very serious regional problem, particularly in areas downwind from high SO_2 and NO_x emitting sources, e.g., coal burning power plants, smelters, and factories. Acid deposition can have many harmful ecological effects in both land and water systems. While acid deposition can damage tree foliage directly, it more commonly stresses trees by changing the chemical and physical characteristics of the soil. In lakes, acid deposition can kill fish and other aquatic life.

The burning of fossil fuels, such as coal and oil, and deforestation can cause concentrations of heat-trapping "greenhouse gases" to increase significantly in our atmosphere. These gases prevent heat from escaping to space, somewhat like the glass panels of a greenhouse. Greenhouse gases are necessary to life as we know it, because they keep the planet's surface warmer than it would otherwise be. But, as the concentrations of these gases continue to increase in the atmosphere, the Earth's temperature is climbing above past levels. Studies show that growth in greenhouse gases and associated changes in weather conditions may increase current air pollution levels.

Air Pollution and Health/Welfare Effects – Improving Our Knowledge

Air pollution continues to have adverse impacts on the human and environmental health of the United States, despite clear evidence that overall air quality has improved. EPA's research program is evolving with growing emphasis on the development of a multi-pollutant approach for assessing the impacts of air pollution. Critical components of this research will inform our understanding of how pollutants from sources impact ambient air concentrations, how these concentrations relate to exposures, and, in turn, how exposures relate to health and welfare outcomes. Some highlights of current air pollution research activities include:

- EPA-funded **Particulate Matter Research Centers** are conducting cutting-edge research to improve our understanding of how particle pollution affects human health and the sources of particles most responsible for these effects. Research grants focus high-priority issues including human susceptibility, mechanisms of health effects, exposure-response relationships, and the cross-cutting issue of linking health effects with particle pollution sources and components.
- The **Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air)** is investigating the impact of air pollution on the progression of cardiovascular disease among more than 7,000 participants with diverse backgrounds from nine locations. The study will help evaluate if cardiac disease is accelerated by exposure to particle pollution in combination with gaseous pollutants and if some ethnic populations are more susceptible to effects associated with these exposures.
- The **Health Effects Institute's National Particle Components Toxicity (NPACT) Initiative** will build upon the existing scientific foundation for particles to improve our understanding of the toxicity of specific components and characteristics of particle pollution (and ultimately sources of these components).

Air Pollution Sources, Health Effects, and Environmental Effects

Pollutant	Sources	Health Effects	Environmental Effects
Ozone (O_3)	Secondary pollutant formed by chemical reaction of VOCs and NO_x in the presence of sunlight.	Aggravation of respiratory and cardiovascular disease, decreased lung function and increased respiratory symptoms, increased susceptibility to respiratory infection, and premature death.	Damage to vegetation such as impacts on tree growth and reduced crop yields.
Particles	Emitted or formed through chemical reactions (e.g., NO_x, SO_2, NH_3); fuel combustion (e.g., burning coal, wood, diesel); industrial processes; agriculture (plowing, field burning); and unpaved roads.	Aggravation of respiratory and cardiovascular disease, reduced lung function, increased respiratory symptoms, and premature death.	Impairment of visibility, effects on climate, and damage and/or discoloration of structures and property.
Lead	Smelters (metal refineries) and other metal industries; combustion of leaded gasoline in piston engine aircraft; waste incinerators; and battery manufacturing.	Damage to developing nervous system, resulting in IQ loss and impacts on learning, memory, and behavior in children. Cardiovascular and kidney effects in adults and early effects related to anemia.	Harm to environment and wildlife.
Sulfur Dioxide (SO_2)	Fuel combustion (especially high-sulfur coal); electric utilities and industrial processes; and natural sources such as volcanoes.	Aggravation of asthma and increased respiratory symptoms. Contributes to particle formation with associated health effects.	Contributes to the acidification of soil and surface water and mercury methylation in wetland areas. Contributes to particle formation with associated environmental effects.
Oxides of Nitrogen (NO_x)	Fuel combustion (e.g., electric utilities, industrial boilers, and vehicles) and wood burning.	Aggravation of respiratory disease and increased susceptibility to respiratory infections. Contributes to ozone and particle formation with associated health effects.	Contributes to the acidification and nutrient enrichment (eutrophication, nitrogen saturation) of soil and surface water. Contributes to ozone and particle formation with associated environmental effects.
Carbon Monoxide (CO)	Fuel combustion (especially vehicles).	Reduces the ability of blood to carry oxygen to body tissues including vital organs. Aggravation of cardiovascular disease.	None known.
Ammonia (NH_3)	Livestock agriculture (i.e., raising/maintaining livestock for milk, meat, and egg production); fertilizer application.	Contributes to particle formation with associated health effects.	Contributes to eutrophication of surface water and nitrate contamination of ground water. Contributes to particle formation with associated environmental effects.
Volatile Organic Compounds (VOCs)	Fuel combustion and evaporation (especially vehicles); solvents; paint; and natural sources such as trees and vegetation.	Cancer (from some toxic air pollutants) and other serious health problems. Contributes to ozone formation with associated health effects.	Contributes to ozone formation with associated environmental effects.
Mercury	Fuel combustion (especially coal-fired power plants); waste disposal; industrial processes; mining; and natural sources (volcanoes and evaporation from enriched soil, wetlands, and oceans).	Liver, kidney, and brain damage; and neurological and developmental damage.	Deposition into rivers, lakes, and oceans accumulates in fish resulting in exposure to humans and wildlife.
Other Toxic Air Pollutants	Fuel combustion (including particle and gaseous emissions); vehicles; industrial processes; building materials; and solvents.	Cancer, immune system damage, neurological, reproductive, developmental, respiratory, and other health problems. Some toxic air pollutants contribute to ozone and particle pollution with associated health effects.	Harmful to wildlife and livestock. Some toxic air pollutants accumulate in the food chain. Some toxic air pollutants contribute to ozone and particle pollution with associated environmental effects.

SOURCES OF AIR POLLUTION

Air pollution consists of gas and particle contaminants ($PM_{2.5}$ and PM_{10}) that are present in the atmosphere. Gaseous pollutants include SO_2, NO_x, ozone (O_3), carbon monoxide (CO), volatile organic compounds (VOCs), certain toxic air pollutants, and some gaseous forms of metals. Particle pollution includes a mixture of compounds. The majority of these compounds can be grouped into four categories: sulfates, nitrates, elemental carbon, organic carbon, and "crustal" material.

Some pollutants are compounds that are released directly into the atmosphere. These include gases such as SO_2 and some particles, such as soil and soot. Other pollutants are formed in the air. Ground-level ozone forms when emissions of NO_x and VOCs react in the presence of sunlight. Similarly, some particles are formed. For example, particle sulfates are the product of SO_2 and ammonia (NH_3) gases reacting in the atmosphere. Weather plays an important role in the formation of air pollutants, as discussed later in the ozone and particle pollution sections.

EPA tracks direct emissions of air pollutants and emissions that contribute to air pollution formation, also known as precursor emissions. Emissions data are compiled from many different organizations, including industry and state, tribal, and local agencies. Some emissions data are based on actual measurements while others are estimates.

Emissions, in general, are emitted from large stationary fuel combustion sources (such as electric utilities and industrial boilers), industrial and other processes (such as metal smelters, petroleum refineries, manufacturing facilities, and solvent utilization), and mobile sources including highway vehicles and non-road sources (such as mobile equipment, marine vessels, aircraft, and locomotives). Sources emit different combinations of pollutants. For example, electric utilities release SO_2, NO_x, and particles. Figure 1 shows the distribution of national total emissions estimates by source category for specific pollutants for 2007. Highway vehicles and non-road mobile sources together contribute approximately three-fourths of national CO emissions. Electric utilities contribute about 70 percent of national SO_2 emissions. Agricultural operations (other processes) contribute nearly 80 percent of national NH_3 emissions. Almost 50 percent of the national VOC emissions are coming from highway vehicles and solvent use (other processes). Pollutant levels differ across regions of the country and within local areas, both urban and rural, depending on the size and type of sources present.

The Clean Air Act and EPA have established a list of 187 air toxics (also known as hazardous air pollutants—HAPs). These pollutants are known or are suspected of causing serious health effects, such as cancer, birth defects, or reproductive effects. Many of the VOCs (e.g., benzene, 1,3-butadiene, and chloroform) and particles (e.g., arsenic, lead, and manganese) are toxic air pollutants, as shown in Figure 2.

A number of sources (e.g., stationary fuel combustion, industrial processes, mobile sources) emit both particle and gaseous toxic air pollutants that contribute to both ozone and particle formation. For example, diesel exhaust contains particles as well as VOCs, some of which are toxic.

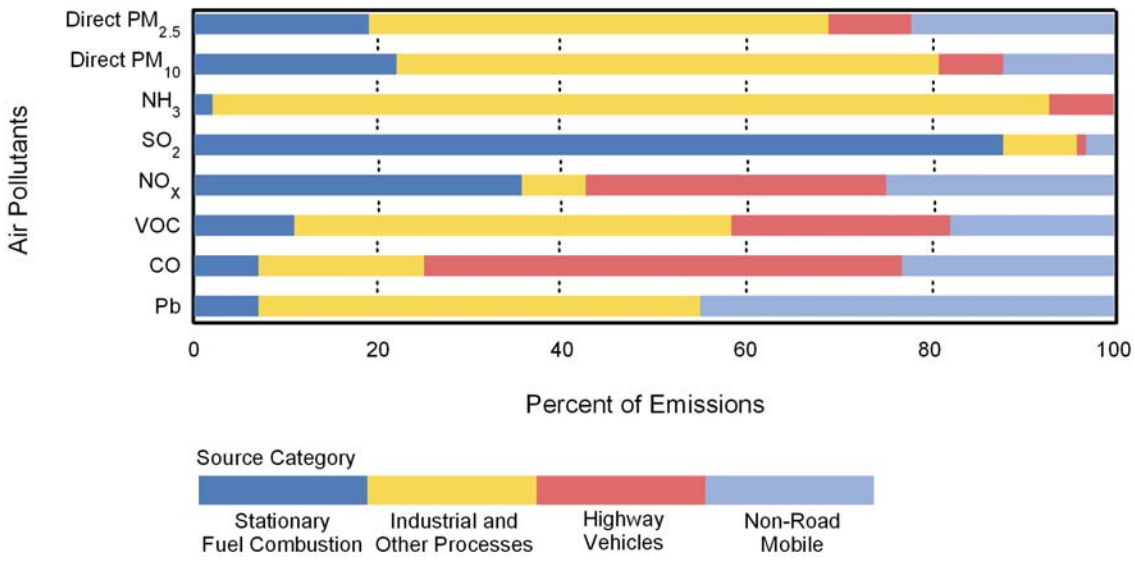


Figure 1. Distribution of national total emissions by source category for specific pollutants, 2007.

Most toxic air pollutants come from a variety of source types. For example, though most benzene emissions are from highway vehicles, benzene is also emitted by some stationary fuel combustion, industrial, and non-road mobile sources.

Control programs that target specific source types can provide multiple benefits. For example, lowering VOC emissions from vehicle sources reduces toxic air pollutant levels and also reduces VOCs that contribute to ozone formation. Lowering NO_x emissions from electric utilities and industrial boilers reduces the NO_x contribution to both ozone and nitrate particle formation, both of which contribute to smog and reduced visibility.

Energy production and transportation sources contribute to CO_2, VOC, SO_2, and NO_x emissions which affect greenhouse gases and the formation of ozone and particle pollution. Reducing energy consumption and vehicle use, or converting to alternative or more efficient energy sources will improve health protection and reduce environmental effects.

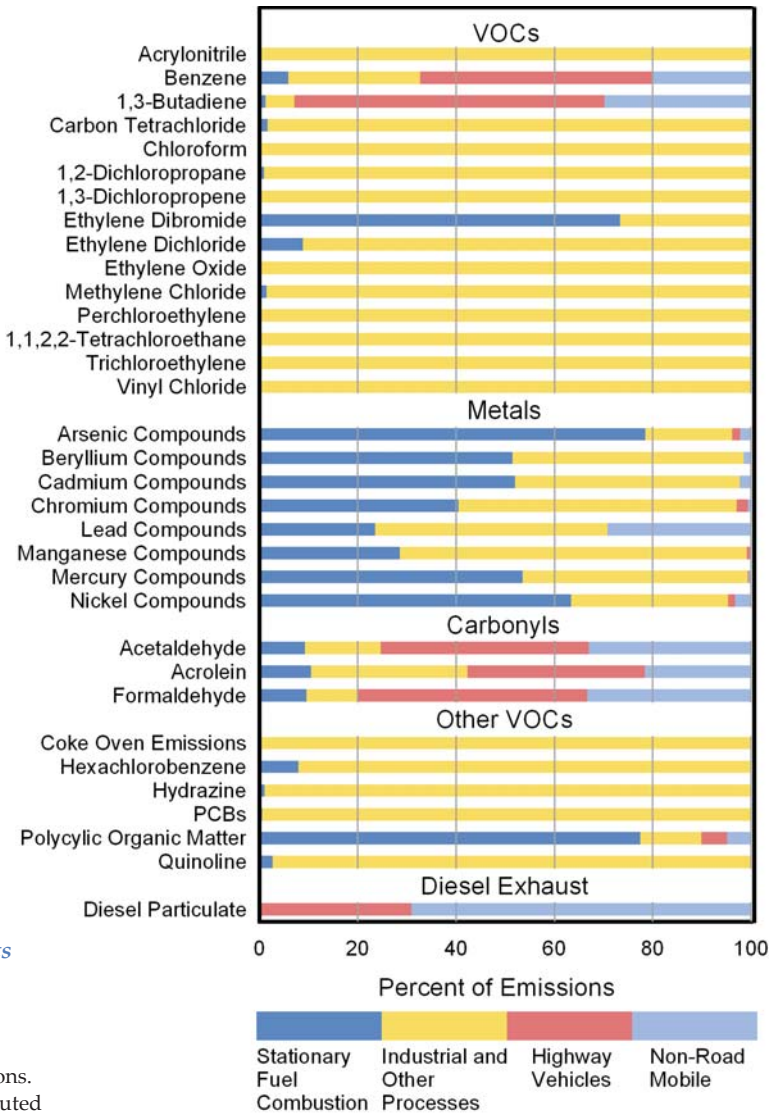


Figure 2. Distribution of national total emissions by source category for individual urban toxic air pollutants and diesel particle pollution, 2005.

Note: Contributions of aldehyde emissions (formaldehyde and acetaldehyde) are for primary direct emissions and do not include secondary aldehydes formed via photochemical reactions. Contributions from fires are not included. In 2005, fires contributed roughly 35 percent of the polycyclic organic matter, 15 percent of the benzene, 37 percent of the 1,3-butadiene, 50 percent of the formaldehyde, 67 percent of the acrolein, and 24 percent of the acetaldehyde.

Emissions Included in this Report

- PM emissions are directly emitted particles only. They do not include gaseous emissions that condense in cooler air (i.e., condensibles) or emissions from fires and resuspended dust.
- SO_2, NO_x, VOC, CO, and lead emissions are from human activity sources only.
- NH_3 emissions are primarily from animal livestock operations and are estimated using population data (e.g., cattle, cows, pigs, poultry) and management practices.
- 2007 emissions were derived from the 2005 emissions inventory, except for SO_2 and NO_x emissions, which were derived from measured data from electric utilities.
- Highway vehicle emissions were based on emission measurements from vehicle testing programs.
- Emissions data were compiled using the best methods and measurements available at the time.

TRACKING POLLUTANT EMISSIONS

Since 1990, air pollutant emissions have declined, with the greatest percentage drop in lead emissions. The removal of lead from gasoline used in highway vehicles is primarily responsible for the 72 percent decrease in lead emissions. NH_3 shows the least percentage drop, four percent. While $PM_{2.5}$ emissions have declined by over one half, PM_{10}, NO_x, and VOC emissions have declined by around one third, and SO_2 and CO emissions have declined by more than one-third, as shown in Table 1.

Table 1. Change in annual national emissions per source category (1990 vs. 2007) (thousand tons).

Source Category	$PM_{2.5}$	PM_{10}	NH_3	SO_2	NO_x	VOC	CO	Pb
Stationary Fuel Combustion	-693	-722	+40	-9036	-4894	+621	-207	-0.410
Industrial and Other Processes	-224	-43	-353	-844	+229	-2809	+8442	-2.621
Highway Vehicles	-223	-235	+152	-412	-4029	-5786	-68645	-0.421
Non-road Mobile	-49	-62	-28	-25	+383	-12	-2685	-0.153
Total Change (thousand tons)	-1189	-1062	-189	-10267	-8311	-7986	-63095	-3.604
Percent Change (1990 vs. 2007)	-51%	-33%	-4%	-45%	-33%	-35%	-44%	-72%

Note: Lead (Pb) emission changes are from 1990 to 2002.

The combined emissions of the six common pollutants ($PM_{2.5}$, SO_2, NO_x, VOCs, CO, and lead) dropped 41 percent since 1990, as shown in Figure 3. This progress has occurred while the U.S. economy continued to grow, Americans drove more miles, and population and energy use increased. These emissions reductions resulted from a variety of control programs through regulations and through voluntary partnerships between federal, state, local, and tribal governments; academia; industrial groups; and environmental organizations.

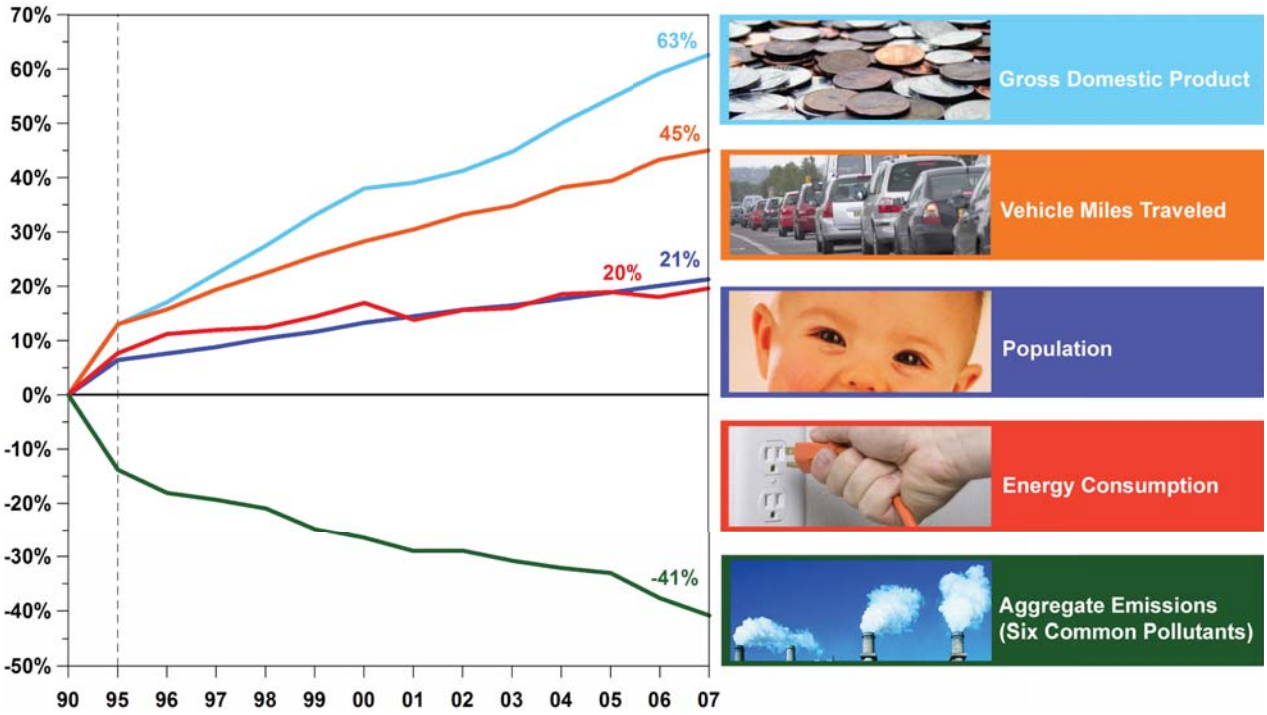


Figure 3. Comparison of growth measures and emissions, 1990-2007.

Note: The U.S. Department of Transportation's Federal Highway Administration reports that cumulative travel for January-April 2008 is down by 2.1 percent compared to the same period in 2007.

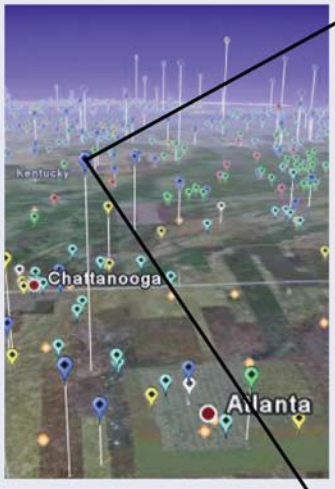
Emissions Where You Live

To get emissions information at a state or local level, visit http://www.epa.gov/air/emissions/where.htm. Here you can find emissions totals for a state or county grouped by major source types, or select Google Earth to see nearby sources of emissions. Zoom to the area of interest, tilt the map to see emissions levels, select a site for facility information, or zoom closer for an aerial photo.

Zoom to Atlanta

Aerial photo

Tilt to see emissions levels



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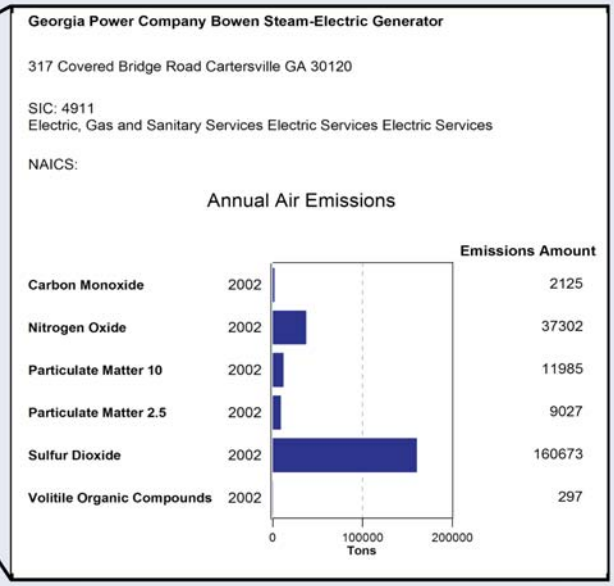

As of May 2008